

SIX FLAGS NEW ENGLAND	
SUBJECT: Electrical Safety/ Arc Flash	SAFETY REFERENCE MANUAL
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EFFECTIVE: January 2016 Six Flags	SUPERSEDES: ALL PREVIOUS

Six Flags, Inc.

Electrical Safety Program

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Purpose

- The purpose of this document is to establish a safe work environment for Six Flags, Inc employees that are exposed to work related electrical hazards.
- This program was prepared with the intent to meet the requirements of the following regulations. It is not the intent to replace the following and the following should always be referenced as the final regulation.
 - a. OSHA 29 CFR 1910, Subpart S: Electrical safety requirements that are necessary for the practical safeguarding of employees in their workplace.
 - b. OSHA 29 CFR 1926 Subpart K: Electrical safety requirements that are necessary for the practical safeguarding of employees involved in construction work.
 - c. NFPA 70E: Standard for Electrical Safety in the Workplace.
 - d. NFPA 70: National Electric Code
 - e. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.

Drawings and Panel Schedules

- All electrical drawings and panel schedules shall be up-to-date. The drawings shall be complete, from the source of electrical energy to the final branch circuit including the device and or equipment. It is strongly recommended to have documentation that indicates the path in which the equipment or devices receive electrical energy (Pipe Schedules).
- If the park electrical drawings and panel schedules are not up-to-date, then there shall be a plan in place and a schedule for establishing up-to-date drawings and panel schedules. The drawings and schedules should be completed no later than beginning of January 2012 (?).

Note: It is recommended to have simple single line drawings for hazardous Electrical Energy Control.

- There shall be an Equipment Data Base of all utility supply(s), transformers, switch gear, panel boards, motor control centers, local disconnects and fixed equipment.
- Each device in the data base shall include the following.
 - a. Its own designation. The designation shall not be based on a theme name. (Example: **BLD 505 MDP-1**). If the utility transformer is not owned by the park, the designation used by the owner of the transformer (utility company) is recommended.

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Note: It is ok to have a theme name associated with the equipment but the designation should always be referenced when performing electrical work.

- b. Name Plate Data
- c. Source of electrical energy and disconnect means. If the disconnecting means is not within sight, the disconnecting means must be lockable.

Note: To be considered lockable, the locking device must remain in place when the lock has been removed.

Note: When a piece of equipment has an attachment plug, and it disconnects all sources of electrical energy, the attachment plug is considered as a disconnect means.

- d. Required Personal Protective Equipment (PPE)
- e. Shock Hazard Boundary
- f. Flash Protection Boundary
- g. Panel boards with up-to-date panel schedules and source(s) of electrical energy.
- h. Switch boards that are properly labeled indicating the location of the feeder(s) or branch circuit(s) and source(s) of electrical energy.
- i. Purpose
 - o All outlets and switches shall have a circuit number(s) indicating the source of electrical energy, or if it is not practical for cosmetic purposes, then an up-to-date drawing shall exist and be readily available that shows the device(s) and circuit number(s).

Note: it is preferred that a drawing be made available at the panel board.

- o A plan shall be put in place to maintain current single line drawings and panel schedules.

1. Introduction

- 1.1. From this point, the term *employee* will refer to a person that performs electrical work and/or faces electrical hazards of 50 volts or more, RMS or DC Voltage.

FPN 70 Volt sound systems and telephone ring voltage does not have enough potential to create an arc flash, however caution should be used to prevent electrical shock.

- 1.2. From this point, the term *work* is considered to be electrical work.

- 1.3. The park management and safety team are responsible for auditing the safe work practices and procedure checklists of this document, as well as the Six Flags

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Lockout/Tag out program.

1.4. All tables within this document are referenced from NFPA 70E.

2. Definitions

Disconnecting Means. A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

Disconnect Means (Lockable). A device for locking or adding a lock to a disconnecting means. The device shall remain in place with or without the lock installed.

Exposed (as applied to energize electrical conductors or circuit parts). Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

Incident Energy. The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm²).

Insulated. Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

FPN: When an object is said to be insulated, it is understood to be insulated for the conditions to which it is normally subject. Otherwise, it is, within the purpose of these rules, uninsulated.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Live Parts. Energized conductive components.

Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

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Panel board. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic over current devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

Prohibited Approach Boundary: An approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part

Qualified Electrical Worker. An employee who has skills and knowledge related to the construction and operation of electrical equipment and installations and has received training as per Section 3.1 of this document.

Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

Receptacle Outlet. An outlet where one or more receptacles are installed.

Restricted Approach Boundary. An approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over, combined with inadvertent movement, for personnel working in close proximity to the live part.

Shock Hazard. A dangerous condition associated with the possible release of energy caused by contact or approach to live parts.

Switchboard. A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, over current and other protective devices, buses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

Task Qualified Person. An employee trained to perform a specific task or tasks, but does not necessarily possess the knowledge or skills to perform electrical work. This person has received the applicable training in Section 3.1 that is required for the specific task or tasks for which he/she is trained.

Unqualified Person in Training: An employee who is not a qualified person but is in the process of being trained.

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3. General Requirements

3.1. Training

3.1.1. Each employee that performs electrical work and/or faces electrical hazards must be trained. They shall be trained in Six Flags safety related work practices, procedures and checklists. The training shall be classroom and on the job.

3.1.2. *Unqualified:* An employee that is undergoing training shall be considered unqualified and in training.

3.1.3. *Qualified:* An employee must be trained in all the following to be considered as qualified.

3.1.4. *Task Qualified:* an employee trained in specific areas related to a specific task or tasks will be considered task qualified.

3.1.5. *Types of Training:*

3.1.5.1. *Classroom*

- a. Best practices
- b. Emergency Procedures
- c. Working on or near energized conductors or parts
- d. Testing equipment
- e. Energize Work Permit and the documented process
- f. Establishing an Electrically Safe Work Condition
- g. How to perform a Hazardous/Risk Analysis
- h. Shock Hazard Analysis and the associated boundaries.
- i. Flash Hazard Analysis and the associated boundaries.
- j. Personal Protective Equipment (PPE)
- k. Lockout/Tag out
- l. Electrical Energy Control Procedures
- m. Reenergizing equipment

3.1.5.2. *Park Related*

- a. Park best practices
- b. Location of all sources of energy and types of exposure
- c. Understanding the operation of the equipment

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- d. Test equipment
- e. Emergency phone and radio numbers

3.1.5.3. *On the Job Training:* Training provided to an employee who has demonstrated in the classroom the ability to perform duties safely at his or her level of skills and who is under the direct supervision of a qualified person while performing electrical work.

3.1.6. Once an employee has been trained in the above, can demonstrate the ability to perform duties safely and has been through on-the-job training, and the Park feels the employee is qualified, then employee shall be deemed as Qualified. The Qualified employee will be designated as either a Qualified Electrical Worker or a Task Qualified Person.

3.1.7. Each Six Flags Park shall maintain a documented list of both Qualified Electrical Workers and Task Qualified Persons. The list shall be readily available to management and the electrical person in charge for a specific job or task. The documentation should also indicate the types of training for which the employee has been trained.

3.1.8. Each Six Flags Park shall maintain a documented list of unqualified employees in training readily available to management and the electrical person in charge for a specific job or task. The documentation should also indicate the types of training for which the employee has been trained.

3.1.9. Refresher training and testing shall be incorporated with the mandatory company provided OSHA annual training.

3.2. Working on or Near Electrical Conductors or Circuit Parts

3.2.1. *Live parts* to which an employee might be exposed shall be put into an electrically safe work condition, as per the method described in Section 4 of this document, before an employee works on or near them, unless work on energized components can be justified according to Section 5 of this document.

3.2.2. *Live parts in an unsafe work condition:* Only Qualified Electrical Workers shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition provided Section 5 of this document is followed.

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3.2.3. Working on or near exposed electrical conductors or circuits that might become energized: Prior to working on or near exposed electrical conductors and circuit parts operating at 50 volts or more, lockout/tag out devices shall be applied in accordance with the Six Flags Lockout/Tag out program. If, for some reason, the lockout/tag out devices cannot be applied, the equipment is considered to be energized, and Section 5 of this document must be followed.

4. Establishing an Electrically Safe Work Condition

4.1. Introduction

4.1.1. All electrical circuit conductors and circuit parts shall be considered energized until the source(s) of energy is (are) removed, at which time they shall be considered deenergized. All electrical circuit conductors and circuit parts shall not be considered to be in an electrically safe condition until Steps (a) thru (j) of Section 4.2 of this document are completed.

4.2. Safe Work Condition Process

4.2.1. Steps (a) thru (j) detail the process to achieve an electrically safe work condition and shall be performed by two persons, one person must be a Qualified Electrical Worker and the second person can be either a Qualified Electrical Worker or Task Qualified Person. At a minimum, the second person must be trained in emergency procedures and know how to establish an Electrically Safe Work Condition. The Qualified Electrical Worker must perform the electrical work and tests, and the second trained or qualified person must witness the work and insure the safety of the Qualified Electrical Worker.

- a. Check applicable up-to-date drawings, diagrams, and identification tags.
- b. Determine all possible source(s) of electrical supply to the specific equipment.
- c. Establish Approach Boundaries, Flash Protection Boundary and the proper Personal Protective Equipment (PPE)
Note: Prior to the steps (a) thru (j) being completed, it is assumed that the equipment is not in a safe work condition; therefore, the proper Personal Protective Equipment must be worn and the associated boundaries must be enforced.
- d. Whenever possible, remove the load current by shutting off the equipment in the normal manner.
- e. After properly interrupting the load current, open the disconnecting device(s)

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for each source of electrical energy.

- f. At the earliest point possible in the following steps, apply the lockout/tagout device in accordance with the Six Flags lockout/tagout program.
- g. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn to the disconnected position.
- h. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part, both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.
- i. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts with properly rated grounding straps. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply properly rated grounding straps.
- j. Check to insure the lockout/tag out device is installed and secured properly.

4.2.2. These requirements shall apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment.

4.3. Principles of Lockout/Tag out Execution

4.3.1. **Employee Involvement:** Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tag out process.

FPN: An example of direct exposure is the qualified electrical worker who works on the motor starter control, the power circuits, or the motor. An example of indirect exposure is the person who works on the coupling between the motor and compressor.

4.4. Hazardous Electrical Energy Control Procedures:

4.4.1. When working on or near electrical equipment, there are three forms of electrical energy control: individual employee control, simple lockout/tag out, and complex lockout/tag out.

FPN: To establish a safe work condition follow procedures outlined in 4.2.1 of this document.

4.4.2. **Individual Control Procedure** by a Qualified Electrical Worker shall be permitted when equipment with exposed conductors and circuit parts is deenergized for minor

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maintenance, servicing, adjusting, cleaning, inspection, operating conditions and similar tasks. The work shall be permitted to be performed without the placement of lockout/tag out devices on the disconnecting means provided the disconnecting means is adjacent to the conductor, circuit parts, and equipment on which the work is performed, the disconnecting means is clearly visible to the individual Qualified Electrical Worker involved in the work and the work must not continue for more than one work shift. The Qualified Electrical Worker must be continuously within site of the equipment and its disconnecting means. A second person that has been trained in emergency procedures must be present to insure the safety of the Qualified Electrical Worker.

The Individual control does not need to be documented.

4.4.3. Simple Lockout/Tag out Procedure: All lockout/tag out procedures that are not under *individual* Qualified Electrical Worker *control* or *complex lockout/tag out* shall be considered simple *lockout/tag out*. All lockout/tag out procedures that involve only a Qualified Electrical Worker(s) deenergizing one set of conductors or circuit part source for the sole purpose of performing work on or near electrical equipment shall be considered to be a simple lockout/tag out and the following shall apply:

- a. A second person that has been trained in emergency procedures must be present.
- b. Each worker shall be responsible for his or her own lockout/tag out.

Simple lockout/tag out does not need to be documented.

4.4.4. Complex Lockout/Tag out Procedure: A complex lockout/tag out exists when one or more of the following are present:

- a. Multiple energy sources
- b. Multiple crews
- c. Multiple locations
- d. Multiple employees
- e. Different disconnect means
- f. Particular sequences
- g. A job that continues for more than one work period

4.4.4.1. A person must be in charge of a complex lockout/tag out situation. Such a person shall be a Qualified Electrical Worker who is specifically appointed

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with overall responsibility to ensure that all energy sources are under lockout/tag out and to account for all persons working on the job/task.

4.4.4.2. All complex lockout/tag out procedures shall be documented daily and require a written plan of execution that identifies the person in charge.

4.4.4.3. All complex lockout/tag out requires a written list of all persons who might be exposed to electrical hazards in the course of the lockout/tag out. FPN Six Flags Lockout/Tag out procedures must be followed.

4.4.4.4. Under no circumstance shall a single employee establish an electrically safe work condition if the hazardous electrical energy controls procedure is complex. Two Qualified Electrical Workers must establish an electrically safe work condition using the Establishing an Electrical Safe Work Condition Checklist in annex 6.3.

5. Working On or Near Live Parts

5.1. Justification for Work:

5.1.1. Live parts, to which a Qualified Electrical Worker might be exposed, shall be put into an electrically safe work condition before the employee works on or near them, unless any of the following apply.

- a. Deenergizing introduces additional or increased hazards, or is infeasible due to equipment design or operational limitations.
- b. The **Qualified Electrical Worker** is performing testing or trouble shooting as permitted in section 5.2.2.
- c. If there will be no increased exposure to electrical burns or to explosion due to electric arcs, i.e. energized parts that operate at less than 50 volts to ground.

5.2. Energized Electrical Work Permit:

5.2.1. If live parts are not placed in an electrically safe work condition, work to be performed shall be considered energized electrical work and an *Energized Work Permit* shall be filled out and approved before the work can begin. An *Energized Work Checklist* shall be filled out at the beginning of the job and at the beginning of

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each work shift. See Annex 6.1 and 6.2 of this document for an Energized Work Permit and Energized Work Checklist.

5.2.2. Exemptions to Work Permit. Work performed on or near live parts by Qualified Electrical Workers related to tasks such as testing, troubleshooting or voltage measuring shall be permitted to be performed without an energized electrical work permit, provided the following conditions are met.

- a. The employee performing the work is a Qualified Electrical Worker.
- b. A second employee that has been trained in emergency procedures is present to monitor the safety of the qualified employee performing the work.
- c. Single line drawings or equivalent are up-to-date.
- d. The source(s) of electrical energy has been identified.
- e. The disconnect means is readily available.
- f. The equipment has been labeled with the following.
 - i. Voltage & Amperage
 - ii. Approach Boundaries
 - iii. Hazardous Risk Category
 - iv. PPE Required
- g. Proper Personal Protective Equipment (PPE) is worn in the hazardous areas.
- h. The area is secured from unauthorized persons.
- i. The work being done is one of the following.
 - i. Troubleshooting
 - ii. Testing
 - iii. Voltage or Amperage Measuring

5.3. Hazard Analysis and Approach Boundaries to Live Parts:

A Shock Hazard Analysis and an Arc Flash Analysis shall be performed and reviewed by the Qualified Electrical Worker before approaching live parts. The shock hazard analysis will establish three boundaries: Limited, Restricted and Prohibited. The flash hazard analysis will establish the Flash Protection Boundary. An approved Shock Hazard analysis and Arc Flash hazard analysis will meet all of the following conditions.

- a. A shock hazard analysis as per 5.3.1 has been performed
- b. A flash hazard analysis as per 5.3.3. has been performed
- c. The equipment is listed in the equipment data base and the information is

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correct.

- d. The applicable drawings are up-to-date
- e. The equipment is field marked with an approved detailed label as show in Figure 5.4.3.1

5.3.1 Shock Hazard Analysis:

All points of an electrical system including equipment operating at 50 volts or more, where an employee might be exposed to a shock hazard, shall be required to have a shock hazard analysis performed in order to protect personnel from the possibility of being injured. The shock hazard analysis shall determine the following.

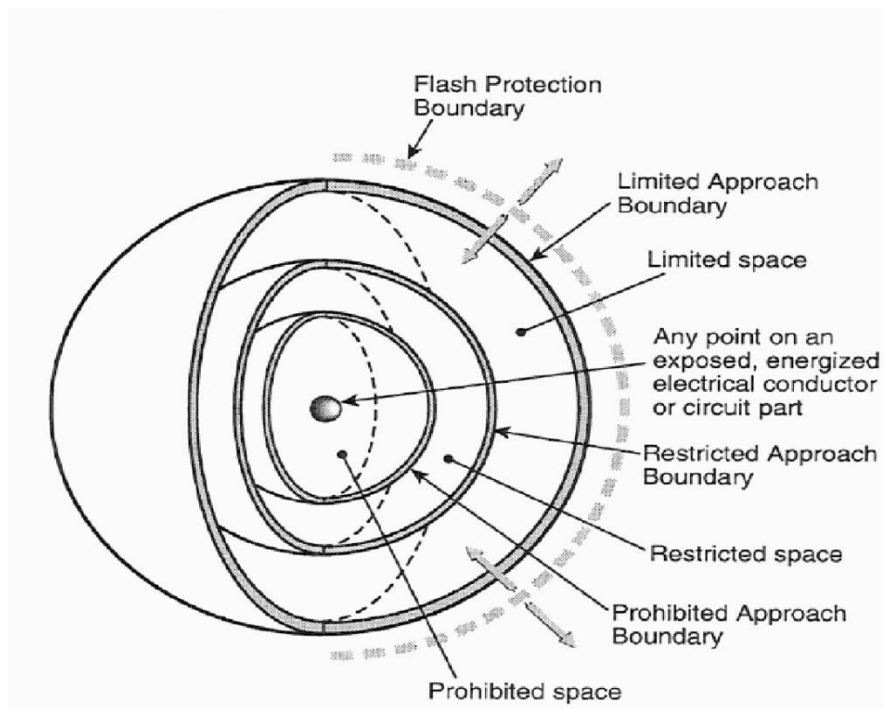
- a. The voltage at which personal will be exposed
- b. The Personal Protective Equipment (PPE) that people within the approach boundaries shall use.
Note: The flash hazard analysis will also determine the requirements for Personal Protective Equipment (PPE)
- c. The approach boundaries (Limited, Restricted and Prohibited).
- d. The Shock hazard analysis shall be documented in the equipment database and shall be field marked with a label to warn qualified person(s) of potential shock hazards. See Figure 5.4.3.1.

5.3.2 Shock Hazard Boundaries:

The Limited, Restricted or Prohibited boundary will establish the outer edge of the respective hazardous space (see figure 5.3.2).

Figure 5.3.2

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Note: The hazardous boundaries and spaces are three dimensional and the requirements of the spaces will need to be enforced in all directions from the exposed live part

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5.3.2.1 Approach Boundary distances from the exposed live part shall be determined by (Table 5.3.2)

Table 5.3.2 Approach Boundaries

-1 Nominal System Voltage Range, Phase to Phase	-2	-3	-4 Restricted Approach Boundary ¹ ; Includes Inadvertent Movement Adder	-5 Prohibited Approach Boundary ¹
	Limited Approach Boundary ¹ Exposed Movable Conductor	Exposed Fixed Circuit Part		
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 750	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	304.8 mm (1 ft 0 in.)	25.4 mm (0 ft 1 in.)
751 to 15 kV	3.05 m (10 ft 0 in.)	1.53 m (5 ft 0 in.)	660.4 mm (2 ft 2 in.)	177.8 mm (0 ft 7 in.)
15.1 kV to 36 kV	3.05 m (10 ft 0 in.)	1.83 m (6 ft 0 in.)	787.4 mm (2 ft 7 in.)	254 mm (0 ft 10 in.)
36.1 kV to 46 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	838.2 mm (2 ft 9 in.)	431.8 mm (1 ft 5 in.)
46.1 kV to 72.5 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	965.2 mm (3 ft 2 in.)	635 mm (2 ft 1 in.)
72.6 kV to 121 kV	3.25 m (10 ft 8 in.)	2.44 m (8 ft 0 in.)	991 mm (3 ft 3 in.)	812.8 mm (2 ft 8 in.)
138 kV to 145 kV	3.36 m (11 ft 0 in.)	3.05 m (10 ft 0 in.)	1.093 m (3 ft 7 in.)	939.8 mm (3 ft 1 in.)
161 kV to 169 kV	3.56 m (11 ft 8 in.)	3.56 m (11 ft 8 in.)	1.22 m (4 ft 0 in.)	1.07 m (3 ft 6 in.)
230 kV to 242 kV	3.97 m (13 ft 0 in.)	3.97 m (13 ft 0 in.)	1.6 m (5 ft 3 in.)	1.45 m (4 ft 9 in.)
345 kV to 362 kV	4.68 m (15 ft 4 in.)	4.68 m (15 ft 4 in.)	2.59 m (8 ft 6 in.)	2.44 m (8 ft 0 in.)
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.43 m (11 ft 3 in.)	3.28 m (10 ft 9 in.)
765 kV to 800 kV	7.24 m (23 ft 9 in.)	7.24 m (23 ft 9 in.)	4.55 m (14 ft 11 in.)	4.4 m (14 ft 5 in.)

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5.3.2.2 Approach to Exposed Live Parts Operating at 50 Volts or More: No

person shall approach or take any conductive object closer to exposed live parts operating at 50 volts or more than the Restricted Approach Boundary unless the person is a Qualified Electrical Worker and any of the following apply:

- a. The Qualified Electrical Worker is insulated or guarded from the live parts operating at 50 volts or more (insulating gloves or insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is being performed), and no un-insulated part of the Qualified Electrical Worker's body crosses the Prohibited Approach Boundary.
- b. The live part operating at 50 volts or more is insulated from the Qualified Electrical Worker and from any other conductive object at a different potential.
- c. The Qualified Electrical Worker is insulated from any other conductive object.

5.3.2.3 Unqualified Person Working At or Close to the Limited Approach

Boundary: Where one or more Unqualified persons are working at or close to the Limited Approach Boundary, the designated person in charge of the work space where the electrical hazard exists shall cooperate with the designated person in charge of the Unqualified person(s) to ensure that all work can be done safely. This shall include advising the unqualified person(s) of the electrical hazard and warning him or her to stay outside of the Limited Approach Boundary.

5.3.2.4 Unqualified Person Entering the Limited Approach Boundary: Where

there is a need for an unqualified person(s) to cross the Limited Approach Boundary, a Qualified Electrical Worker shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the Limited Approach Boundary. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the Restricted Approach Boundary.

5.3.3 Flash Hazard Analysis:

All points of an electrical system including equipment operating at 50 volts or more, where an employee might be exposed to an arc flash shall be required to have a flash hazard analysis in order to protect personnel from the possibility of being injured. The flash hazard analysis shall determine the following.

- a. Flash Protection Boundary
- b. Personal Protective Equipment (PPE) that people within the flash protection boundary shall use.

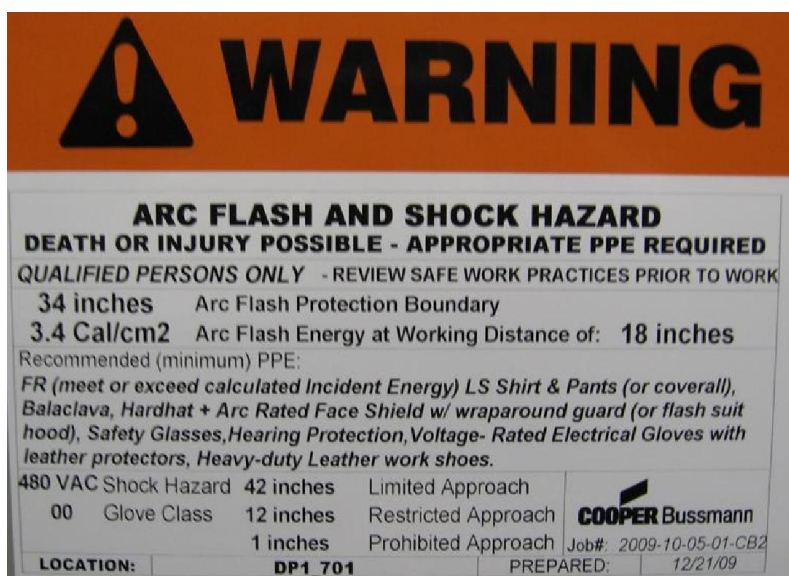
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Note: The Shock Hazard Analysis will also determine the requirements for Personal Protective Equipment (PPE)

5.3.3.1 The flash hazard analysis shall be documented in the equipment database and shall be field marked with a detailed label to warn qualified person(s) of potential electric arc flash hazards and shall indicate the following.

- Arc Flash and Shock Hazard, Appropriate PPE Required
- Flash Hazard Boundary
- Calories per square centimeter
- PPE Level and PPE Required
- Shock Hazard
- Approach Boundaries
- Equipment designation
- Equipment name

Figure 5.4.3.1. Detailed Label



5.3.4 Flash Protection Boundary:

For systems that are 600 volts or less, the Flash Protection Boundary shall be 4.0 ft, based on the product of clearing times of 6 cycles (0.1 second) and the

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available bolted fault current of 50 kA, or any combination not exceeding 300 kA cycles (5000 ampere seconds), or the flash protection boundary may be calculated alternatively under engineering supervision.

Any of the following requires the Flash Protection Boundary to be calculated under engineering supervision.

- a. Alternative calculation.
- b. For clearing times and bolt fault currents above 300 kA cycles.
- c. Voltages above 600 volts.

5.4 Protective Clothing and Personal Protective Equipment (PPE):

- 5.4.1 Where it has been determined that work will be performed within the Flash Protection Boundary, the proper Personal Protective Equipment shall be worn. One of the following two methods shall be used for selecting the proper Personal Protective Equipment (PPE).
- a. Under engineering supervision, a detailed flash hazard analysis shall determine the incident energy in calories per square centimeter. The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Flame-resistant (FR) clothing and Personal Protective Equipment (PPE) shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined. This method must be done under engineering supervision.
 - b. As an alternative, the PPE can be selected by the use of tables 5.4.a and 5.4.b and should be done according to the following
 1. Use table 5.4.a to determine the hazard/risk category for a specific Task. The assumed short-circuit current capacities and fault clearing times for various tasks are listed in the Text and Notes. **The Notes must be followed when using the Task Tables.** If a Task is not listed in Table 5.4.a then a detailed flash hazard analysis shall be performed as per Section 5.3 of this document.
 2. Once the Hazard/Risk Category has been identified, Table 5.5.2.b2 (PPE Matrix) shall be used to determine the required personal protective equipment (PPE) for the task. The table lists the requirements for protective clothing and

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other protective equipment based on Hazard/Risk Category numbers 0 through 4. This clothing and equipment shall be used when working on or near energized equipment within the Flash Protection Boundary.

Note: Both larger and smaller available short-circuit currents could result in higher available arc-flash energies. If the available short-circuit current increases without a decrease in the opening time of the over current protective device, the arc-flash energy will increase. If the available short-circuit current decreases, resulting in a longer opening time for the over current protective device, arc-flash energies could also increase.

Note: Energized parts that operate at less than 50 volts are not required to be de-energized to satisfy an “electrically safe work condition.” Consideration should be given to the capacity of the source, any over current protection between the energy source and the worker, and whether the work task related to the source operating at less than 50 volts increases exposure to electrical burns or to explosion from an electric arc.

Note: For tasks not listed or for power systems with greater than the assumed short-circuit current capacity or with longer than the assumed fault clearing times, a flash hazard analysis shall be required in accordance with 5.4.1(a).

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Table 5.4.a Hazardous/Risk Category Classifications *NFPA 70E Table 130.7(C) (9)*

Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)	Hazard/ Risk Category	V-rated Gloves	V-rated Tools
Panel boards or Other Equipment Rated 240 V and Below — Notes 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energize electrical conductors and circuit parts of utilization Equipment fed directly by a branch circuit of the panel board.	1	Y	Y
Panel boards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Notes 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energize electrical conductors and circuit parts of utilization Equipment fed directly by a branch circuit of the panel board.	2*	Y	Y
600 V Class Motor Control Centers (MCCs) — Notes 2 (except as indicated)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y

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Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter “buckets” from MCC — Note 3	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) Note 3	4*	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) Note 3	1	N	N
Work on energize electrical conductors and circuit parts of utilization Equipment fed directly by a branch circuit of the panel board.	2*	Y	Y

600 V Class Switchgear (with power circuit breakers or fused switches)

— Notes 4

Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N

Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 2 (except as indicated)

Lighting or small power transformers (600 V, maximum)	—	—	—
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2*	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N

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Work on energized electrical conductor and circuit parts, including voltage testing	2*	Y	Y
---	----	---	---

Application of safety grounds, after voltage test	2*	Y	N
---	----	---	---

Revenue meters (kW-hour, at primary voltage and current)	2*	Y	N
--	----	---	---

Insertion or removal			
----------------------	--	--	--

Cable trough or tray cover removal or installation	1	N	N
--	---	---	---

Miscellaneous equipment cover removal or installation	1	N	N
---	---	---	---

Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
--	----	---	---

Application of safety grounds, after voltage test	2*	Y	N
---	----	---	---

Insertion or removal of plug-in devices into or from bus ways	2*	Y	N
---	----	---	---

NEMA E2 (fused contactor) Motor Starters, 2.3 kV Through 7.2 kV

Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
--	---	---	---

Contactor operation with enclosure doors closed	0	N	N
---	---	---	---

Reading a panel meter while operating a meter switch	0	N	N
--	---	---	---

Contactor operation with enclosure doors open	2*	N	N
---	----	---	---

Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
--	---	---	---

Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
---	---	---	---

Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y
---	---	---	---

Insertion or removal (racking) of starters from cubicles, doors open and close	4	N	N
---	---	---	---

Application of safety grounds, after voltage test	3	Y	N
---	---	---	---

Removal of bolted covers (to expose bare, energized electrical conductor and circuit parts)	4	N	N
---	---	---	---

Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
---	---	---	---

Insertion or removal (racking) of starter from cubicles of arc resistance construction, tested in accordance with IEEE C37.20.7 doors closed only	0	N	N
---	---	---	---

Metal Clad Switchgear, 1 kV Trough 38 KV

Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
--	---	---	---

CB operation with enclosure doors closed	2	N	N
--	---	---	---

Reading a panel meter while operating a meter switch	0	N	N
--	---	---	---

CB operation with enclosure doors open	4	N	N
--	---	---	---

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Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N

Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N

Arc-Resistance Switchgear Type 1 or 2 (for clearing times 0f<0.5 sec with a perspective fault current not to exceed the arc resistance of the equipment)

CB operation with enclosure doors closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground test device with door closed	2	N	N
Insertion or removal (racking) of voltage transformer on or off the bus door closed	0	N	N

Other Equipment 1 kV Through 38

Metal clad load interrupter switches, fused or unfused	—	—	—
Switch operation of arc resistance construction, tested in accordance with IEEE C37.20.7 doors closed only	0	N	N
Switch operation doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y

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Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hook stick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

General Notes (applicable to the entire table):

- (a) Rubber insulated gloves are rated for the maximum line to line voltage upon which work will be done.
- (b) Insulated and insulated hand tools are rated and tested for the maximum line to line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, Standard Specifications for Insulated Hand Tools.
- (c) Y= yes (required) N= (not required)
- (d) For systems rated less than 1000 volts, the fault currents and upstream protective devices clearing times are based at 18 in. working distance.
- (e) For systems 1KV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
- (f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the Hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the tables)

- 1. Maximum of 25 kA short circuit current available, maximum 0.03 second (2 cycle) fault clearing time.
- 2. Maximum of 65 kA short circuit current available, maximum 0.03 second (2 cycle) fault clearing time.
- 3. Maximum of 42 KA short circuit current available, maximum of .33 sec (20 cycle) fault clearing time.
- 4. Maximum of 35 KA short circuit current available, maximum of .05 sec (30 cycle) fault clearing time.
- 4. 65 kA short circuit current available, 0.33 second (20 cycle) fault clearing time.

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Table 5.4.b Protective Clothing and Personal Protective Equipment: NFPA 70E Table 130.7(C)(10)

Protective Clothing and Personal Protective Equipment (PPE)	
Hazard/Risk Category 0	Protective Clothing & Equipment when (0 to 1.2 CAL)
Protective Clothing No melting (according to ASTM F 1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)
FR Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	Protective Clothing & Equipment when (1.2 to 4 CAL)
FR Clothing Minimum Arc Rating 4 (Note 1)	Arc rated long sleeve shirt (Note 3) Arc rated pants (Note 3) Arc rated coverall (Note 4) Arc rated face shield or arc flash suite hood (Note 7) Arc rated jacket, parka, rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	Protective Clothing & Equipment when (4 to 8 CAL)
FR Clothing Minimum Arc Rating of 8 (Note 1)	Arc rated long sleeve shirt (Note 5) Arc rated pants (Note 5) Arc rated coverall (Note 6) Arc rated face shield or arc flash suite hood (Note 7) Arc rated jacket, parka, rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	Protective Clothing & Equipment when (4 to 8 CAL)
FR Clothing Minimum Arc Rating 8 (Note	Arc rated long sleeve shirt (Note 5)

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1)	<p>Arc rated pants (Note 5)</p> <p>Arc rated coverall (Note 6)</p> <p>Arc rated face shield or arc flash suite hood (Note 10)</p> <p>Arc rated jacket, parka, rainwear (AN)</p>
FR Protective Equipment	<p>Hard hat</p> <p>Safety glasses or safety goggles (SR)</p> <p>Hearing protection (ear canal inserts)</p> <p>Leather gloves (Note 2)</p> <p>Leather work shoes</p>
Hazard/Risk Category 3	Protective Clothing & Equipment when (8 to 25 CAL)
FR Clothing Minimum Arc Rating 25 (Note 1)	<p>Arc rated long sleeve shirt (AR) (Note 8)</p> <p>Arc rated pants (AR) (Note 8)</p> <p>Arc rated coverall (AR) (Note 8)</p> <p>Arc rated flash suit jacket (AR) (Note 8)</p> <p>Arc rated flash suit pants (AR) (Note 8)</p> <p>Arc rated flash suit hood (AR) (Note 8)</p> <p>Arc rated jacket, parka, rainwear (AN)</p>
FR Protective Equipment	<p>Hard hat</p> <p>FR rated head hat liner (AR)</p> <p>Safety glasses or safety goggles (SR)</p> <p>Hearing protection (ear canal inserts)</p> <p>Arch rated gloves (Note 2)</p> <p>Leather work shoes</p>
Hazard/Risk Category 4	Protective Clothing & Equipment when (25 to 40 CAL)
FR Clothing Minimum Arc Rating 40 (Note 1)	<p>Arc rated long sleeve shirt (AR) (Note 9)</p> <p>Arc rated pants (AR) (Note 9)</p> <p>Arc rated coverall (AR) (Note 9)</p> <p>Arc rated flash suit jacket (AR) (Note 9)</p> <p>Arc rated flash suit pants (AR) (Note 9)</p> <p>Arc rated flash suit hood (AR) (Note 9)</p> <p>Arc rated jacket, parka, rainwear (AN)</p>
FR Protective Equipment	<p>Hard hat</p> <p>FR rated head hat liner (AR)</p> <p>Safety glasses or safety goggles (SR)</p> <p>Hearing protection (ear canal inserts)</p> <p>Arch rated gloves (Note 2)</p> <p>Leather work shoes</p>

AN= As required (optional)
Notes

AR= As required

SR= Selection required

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1 Arc rating for a garment or system of garments is expressed in cal/cm2

2 If rubber insulating gloves with leathers protectors are required from Table 5.5.2.b1, additional leather or arc rated gloves are not required. The combination of rubber insulated gloves and leather protectors satisfies the arc flash protection requirement.

3 The FR shirt and pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4

4 Alternate is to use FR coveralls (minimum arc rating 4) instead of FR shirt and FR pants.

5 FR shirt and FR pants used for Hazard/Risk Category 2 shall have a minimum arc rating of 8.

6 Alternate is to use FR coveralls (minimum arc rating 8) instead of FR shirt and FR pants.

7 A face shield with a minimum arc rating of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wrap around guarding to protect not only the face, but also the forehead, ear, neck (or alternatively, an arc flash suit hood) is required.

8 An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3

9 The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.

10 Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face and neck except for the eyes nose areas.

6 Annex

6.1 Energized Work Permit

Energized Work Permit				
Date:	2/1/2010 8:34	Work Permit Number	2/1/2010 8:34	
Location or Building #		Name of the person Filling out this form:		
ARC Flash Boundary				
Shock Boundary		The following signatures indicate that that energized work is justifiable and that the work can be done safely.		
Equipment or Panel #			Name	Signatures
		On Duty Maintenance Manager		
Location to turn off in an emergency		On Duty Safety Manager		
Time				

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Started:		Qualified Electrical Worker 1		
Time Completed:		Qualified Electrical Worker 2		
Justification: Why the equipment cannot be turned off:				
Description of work to be performed:				
Method of securing the boundaries:				
Safety Equipment Required: PPE				
Notes:				
<p style="text-align: center;">Notes:</p> <p>If the Person(s) performing the work or another person is added to the work, a new work permit shall be issued.</p> <p>If the Maintenance Manger or Safety Manager changes during the process of the work, the new manager must be made aware of the work and permit.</p> <p>All Managers and Qualified Electrical Worker(s) must be notified when the work is complete.</p> <p>This permit shall be printed and signed before the work can begin.</p>				

6.2 Energized Work Check List

Energized Work Check Lists	
<p>Must be filled out by a Qualified Electrical Worker</p> <p>This check list must be reviewed at the beginning of the work and at the beginning of the shift.</p> <p>Must be reviewed with all employee(s) at risk</p>	
<input type="checkbox"/>	A plan has been established and reviewed with all employee(s) at risk.

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<input type="checkbox"/>	An emergency plan has been established and reviewed.			
<input type="checkbox"/>	A person in charge has been established and is qualified.			
<input type="checkbox"/>	An Energized Work Permit has been completed and signed.			
<input type="checkbox"/>	Drawings have been reviewed and the source(s) of electrical energy has been identified.			
<input type="checkbox"/>	The source(s) of electrical energy can be turned off quickly in an emergency.			
<input type="checkbox"/>	All means of emergency communication(s) have been identified and are working properly.			
<input type="checkbox"/>	All emergency number(s) are readily available (telephone and radio).			
<input type="checkbox"/>	The shock hazard and flash hazard analysis has been reviewed.			
<input type="checkbox"/>	The proper PPE has been selected and is being worn.			
<input type="checkbox"/>	All boundaries have been secured (arc flash and shock boundaries).			
<input type="checkbox"/>	Only properly rated tools will be used in the restricted and prohibited boundaries.			
<input type="checkbox"/>	Proper safety equipment and tools are readily available			
<input type="checkbox"/>	A second qualified person is present (and is monitoring the safety of the person performing the work. The person monitoring must be outside the arc flash and shock hazard boundaries.			
Notes				
Sign when check list is complete	Name	Signature	Date	Time
Qualified Electrical Worker performing the work				
2nd Qualified person				

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6.3 Establishing an Electrically Safe Work Condition Check List

Establishing an Electrically Safe Work Condition Check List

The following shall be performed by two persons, one being a qualified employee and the second being trained in emergency procedures and how to establish an Electrically Safe Work Condition.

Note: All lockout/tagout should be installed as soon as the disconnect has been opened and verified.

- ☐ The applicable drawings, diagrams and identification tags are up to date.
- ☐ All sources of electrical supply have been identified.
- ☐ All boundaries have been established (Arc Flash and Shock Hazard).
- ☐ The proper PPE is being worn.
- ☐ All practical load currents have been removed.
- ☐ All electrical sources of electrical supply have been disconnected.
- ☐ All disconnect blades have been verified in the full disconnect position or breaker in the full disconnect position.
- ☐ An adequately rated voltage tester has been tested and is working properly.
- ☐ Each phase has been tested phase-to-phase and phase-to-ground with the above voltage tester.
- ☐ The voltage tester has been re-tested and is still working properly.
- ☐ All induced voltage or stored energy has been removed.
- ☐ Properly rated grounding straps have been installed. (If needed)
- ☐ All lockout/tag out have been installed and secured properly.

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Sign when check list is complete	Name	Signature	Date	Time
Qualified Person performing the work				
2nd person verifying				

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6.4 Qualified Electrical Worker - Qualification Check List

Qualified Electrical Worker Qualification Check List	
If the park management chooses to qualify an employee in specific areas rather than qualify the employee throughout the park, leave 13 unchecked and check 14 and list the areas to be qualified on attached page	
1	<input type="checkbox"/> Trained in Emergency Procedures
2	<input type="checkbox"/> Knows how to perform a Hazard/Risk assessment (Shock Hazard and Flash Hazard) and the documented process.
3	<input type="checkbox"/> Trained in Personal Protective Equipment (PPE).
4	<input type="checkbox"/> Trained in Six Flags Lockout Tag out procedures
5	<input type="checkbox"/> Trained in Six Flags best practices
6	<input type="checkbox"/> Knows how to Establishing an Electrically Safe Work Condition
7	<input type="checkbox"/> Trained in Electrical Energy Control procedures
8	<input type="checkbox"/> Trained on Energized Work Permit and the documented process
9	<input type="checkbox"/> Trained on Reenergizing equipment
10	<input type="checkbox"/> Is familiar with the parks system voltages
11	<input type="checkbox"/> The Employee is able to read and understand the parks electrical single line drawings and documentation
12	<input type="checkbox"/> The Employee has demonstrated in the class room and on the job ability to perform the duties safely
13	<input type="checkbox"/> The park management agrees the employee has ability to perform the work safely in specific areas as listed in the attachment.
14	<input type="checkbox"/> The park management agrees the employee is qualified for specific areas. (see attachment page)

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Notes				
	Name	Signature	Date	Time
Park Maintenance Director				
Electrical Supervisor				
Employee				
<p align="center">Task Qualified Person Qualification for Specific Areas</p>				
List the specific areas to be qualified				
<div> <div>1</div> <input type="checkbox"/> </div> <div> <div>2</div> <input type="checkbox"/> </div> <div> <div>3</div> <input type="checkbox"/> </div> <div> <div>4</div> <input type="checkbox"/> </div> <div> <div>5</div> <input type="checkbox"/> </div> <div> <div>6</div> <input type="checkbox"/> </div> <div> <div>7</div> <input type="checkbox"/> </div> <div> <div>8</div> <input type="checkbox"/> </div> <div> <div>9</div> <input type="checkbox"/> </div> <div> <div>10</div> <input type="checkbox"/> </div> <div> <div>11</div> <input type="checkbox"/> </div>				

SIX FLAGS NEW ENGLAND	
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Notes

	Name	Signature	Date	Time
Park Maintenance Director				
Electrical Supervisor				
Employee				